GSFC MO&DSD TECHNOLOGY DEVELOPMENT PLAN

TITLE: **TECHNOLOGY FOR MISSION OPERATIONS**	
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BRIEF TECHNICAL SUMMARY *(Objectives and Approach)*

The objective of this element is to prepare for future highly-automated mission operations   that are intended to achieve improved performance and to reduce cost . This will be done by addressing research and development issues that span the time period from the current "master/slave " mission operations paradigm through various levels of autonomy to the proposed era of "peer-to-peer" ground/space operations.

Future automated systems in MO&DSD will be realized through an unprecedented , innovative integration of knowledge-based, user interface/interaction, information management , and systems engineering technologies. These technologies are believed mandatory for an effective and efficient approach to "Lights Out" operations.

Accordingly, development activities within this element are in three areas. The TRENDS (Model-based Trend Analysis) work will provide model-based techniques in support of automated trending analysis of satellite status data. The AGENTS (Distributed Agent-Based Approach for Automated Ground/Space Operations) work is supporting development of advanced agent-based automation aids for Flight Operations Team (FOT) activities and spacecraft automation. Thirdly, the Virtual Environments (VE) work is focused on development of advanced visualization techniques for bringing mission operations personnel up to date on spacecraft status issues when operating in a "Lights Out" context.

This work will maintain a close working relationship with operations personnel to provide the guidance needed for a well-focused and relevant program. A systematic plan will be followed for the phased transition of new technologies into mission operations that will include frequent prototype demonstrations of work in process to ensure alignment with true operations needs.

APPROVALS		
WORK AREA MANAGER:	DIVISION MANAGER:	GSFC PROGRAM MANAGER:

JUSTIFICATION AND BENEFITS

The technology and systems engineering development successes that will be realized by this element's work will contribute significantly to the advancement of Code 500 mission operations systems in both qualitative and quantitative ways.

The TRENDS work will contribute to enhanced performance by analysts in detecting and analyzing trends in spacecraft status data. The model management approach being developed will support the rapid and cost-effective development of trending support systems for a wide range of applications. The model-based approach to trending will result in technically well-founded and consistent analyses of trend data. The model-based reasoning techniques that result from this work will be integrated into the AGENT work on a regular basis.

The AGENT work will contribute to a new and needed level of automation in ground/space operations systems. Once the agent-based approach to automation is established, operators will be able to interface with their systems in a goal-directed fashion, which should significantly increase their efficiency in accomplishing operations-related tasks. Because the agent-based approach to automation provides goal-directed capabilities, a broader range of real-time automation possibilities will be provided. This will eliminate the need for the development of lower-level autonomous or semi-autonomous processes. Development cost-savings will be realized.

The VE work will provide a next-generation approach to information visualization in mission operations centers. Clearer presentation of mission-critical data and information to members of the Flight Operations Team will result in a clearer understanding of spacecraft status and more precise decision making. The VE work will also significantly contribute to advanced mission planning activities by providing the opportunity to visualize and analyze "what-if" scenarios. The VE work will be integrated into the agent-based automated ground/space system prototypes on a regular basis.

APPROACH AND PLAN

The planned development efforts for this element are:

a. Continued development of the TRENDS system. This involves:
    - Development of a generalized version of the model management environment DASME (Data Analysis and System Modeling Environment) and the use of this environment in the development of a model-based, trend analysis capability. A major revision of the DASME tool will be undertaken to provide a better user interface.
    - The application of neural network techniques for the recognition of trend patterns, and possibilistic reasoning techniques for dealing with incomplete model data. Also case-based reasoning, genetic algorithms, and genetic programming will be investigated as contributing technologies for the automated trending capability.

b. Continued development of agent technologies. This work includes:
    - Continued development and demonstration of agent-based prototypes. These prototypes will be used to validate and/or update the current agent model concepts and demonstrate the utility of agent-based approaches to ground/space automation.
    - Commencement of an effort to design and begin prototyping of an agent-based ground system. This work will be done with the Mission Operations Division.
    - Investigation of agent technology in a virtual enterprise context. This will contribute to an expansion of the use of agent technology at Goddard. This work will be done with the Flight Assurance Directorate, Code 300.
    - Investigation of the role that agent technology can play as an intelligent information management resource in support of rapid proposal development. This work will be done in collaboration with Code 700.

c. Continued development of data/information visualization systems for use in mission operations environments. This includes:
    - Continued development of a system focusing on the development of an EUVE thermal model visualization for use in the EUVE control center at the University of California Berkeley.
    - Continued development of a VE testbed for use in developing advanced data and information visualization applications in mission operations. This testbed initially consists of spacecraft ground system data visualization prototypes.
    - Conducting additional cognitive studies experiments.

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DELIVERABLES

ITEM	DATE

Model-based Trending - TRENDS

a. Revised Data Analysis and System Modeling Environment (ASME)   09/97

b. Develop position paper on the integration of model-based
   reasoning capability into an agent-based system   07/97

c. Prototype model-based reasoning capability - for evaluation   09/97

Agent Prototype - AGENTS

a. Agent-based ground system (preliminary)   07/97

b. Initial agent-based system prototype for proof of concept evaluation   09/97

Data/Information Visualization

a. Thermal-model visualization prototype (revisions)   03/97

b. Data/Information visualization prototypes   09/97

c. Initial integration into prototype "Lights Out" agent-based, automated,
   ground/space system   09/97

RESOURCE REQUIREMENTS

Task Name	NASA UPN	FY97 ($K)	FY98 ($K)	FY99 ($K)	FY00 ($K)	FY01 ($K)	FY02 ($K)
Technology for Mission Operations	(315-90-17-02)	345	435	410	450	450	450

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UPN: 315-90-17-02: TECHNOLOGY FOR MISSION OPERATIONS

SCHEDULE

TECHNOLOGY FOR MISSION OPERATIONS	FY97				FY98		FY99	FY00	FY01	FY02
	Q1	Q2	Q3	Q4	Q1/2	Q3/4				
Model Based Trending - TRENDS										
a. Revised DASME										
b. Position paper developed										
c. Prototype reasoning agent capability										
Agent Prototype - AGENTS										
a. Agent-based ground system (preliminary)										
b. Initial Agent-based ground system prototype for proof of concept evaluation										
Data/Information Visualization (VE										
a. Thermal-model visualization prototype (revisions)										
b. Data/Information visualization prototypes										
c. Initial integration into "Lights Out" agent-based, automated, ground/space system										
Resources by FY ($K):	345				435		410	450	450	450